

5 We claim:

1. A method of communicating information over a power line transmitting  
power at a power line frequency, the method comprising:  
creating a modulated signal representative of the information and having a  
carrier frequency which is derived from the power line frequency and a bandwidth  
10 of less than ten Hertz and wherein the modulated signal is created using a single  
modulation operation; and  
coupling the modulated signal onto the power line.
2. The method of claim 1 wherein the modulated signal is a frequency shift key  
signal.
- 15 3. The method of claim 1 wherein the input is converted into space and mark  
frequencies.
4. The method of claim 1 wherein the carrier frequency is a multiple of the power  
line frequency.
5. The method of claim 1 wherein the carrier frequency is a non-integer multiple  
20 of the power line frequency selected to fall between the harmonics of the  
power line frequency.
6. The method of claim 1 wherein coupling the modulated signal onto the power  
line applies a voltage signal.
7. The method of claim 1 wherein coupling the modulated signal onto the power  
25 line applies a voltage signal using a resonant circuit.

- 5      8. The method of claim 1 wherein the carrier frequency is about approximately 1  
to 7 kHz.
9. The method of claim 1 wherein coupling the modulated signal onto the power  
line applies a current signal using a current source output.
10. The method of claim 5 wherein the carrier frequency is about approximately  
10      2 KHz.
11. The method of claim 2 wherein the information is arranged in packets of data  
bytes by a data shifter and packet generator which is clocked by a bit clock  
driven by a reference signal derived from the power line frequency.
12. The method of claim 2 wherein the packets use the HDLC synchronous  
15      protocol.
13. A method of transmitting a signal on a power line at transmission frequencies  
numerically derived from the power line frequency, comprising:  
    selecting a transmission frequency for the signal;  
    setting a voltage controlled oscillator to a preset frequency determined by  
20      the transmission frequency;  
    dividing the oscillator output by the transmission frequency to derive an  
internal reference signal;  
    comparing the phase of the internal reference signal to the phase of the  
power line carrier and using the changes in phase angle as a feedback signal in  
25      a frequency lock loop for maintaining the oscillator at the transmission

5 frequency; and

transmitting a signal on the power line using an output stage driven at the transmission frequency.

14. The method of claim 13 wherein the signal is a frequency shift key signal comprised of a sequence of space frequency and mark frequency pulses.

10 15. A method of transmitting a modulated data signal on a power line at frequencies numerically derived from the power line frequency, comprising:

selecting a mark frequency and a space frequency for the "1"s and "0"s of the data represented by the signal;

15 starting a voltage controlled oscillator at a preset frequency determined by whether the mark frequency or the space frequency is being transmitted;

dividing the oscillator output by either the mark frequency or the space frequency, depending upon which is being transmitted, to provide an internal reference signal;

20 comparing the phase of the internal reference signal to the phase of the power line carrier and providing the changes in phase as a feedback signal in a frequency lock feedback loop to control the frequency of the oscillator

16. A transmitter for sending data on a power distribution line having a power line frequency, comprising:

a bit clock;

25 a data shifter and packet generator for receiving data for transmission and

5 converting it into packets containing a plurality of data bytes transmitted in response to the output of a bit clock;

an A/D converter coupled to receive a signal from the power line at the power line frequency, the A/D converter coupled for delivering an output signal;

a power line frequency tracker circuit coupled to receive an output signal  
10 from the A/D converter and packets from the data shifter and packet generator, the tracker circuit comprising an oscillator circuit constructed and arranged for operating at a mark frequency derived from the power line carrier for "1"s and at a space frequency derived from the power line carrier for "0"s, the oscillator circuit operating as a phase lock loop circuit comparing the phase difference between a  
15 reference signal generated in the tracker circuit and the power line frequency and generating an output signal containing mark and space frequency components, the tracker circuit also delivering an internal time reference for the bit clock; and

a transmitter for coupling the output of the oscillator to the power line for transmission of the mark and space frequency signals having a bandwidth less than  
20 ten Hertz on the power line.

17. The invention of claim 16 wherein the data shifter and packet generator encodes the data for transmission in packets according to a HDLC protocol with each packet preceded by at least six bits of "1"s followed by a "0" and each sequence of five or six "1"s have a extra "0" inserted.

25 18. The invention of claim 16 wherein the data transmitted is in non-return to zero



5           converting the data to a series of pulses;  
              converting the pulses into a frequency division multiplexed signal having a  
              carrier frequency which is numerically derived from the power line frequency and  
              a bandwidth of less than ten Hertz;  
              coupling the frequency division multiplexed signal on the power line.

10    22. The method of claim 21 wherein the input is converted into space and mark  
          frequencies.

          23. The method of claim 21 wherein the carrier frequency is selected to fall  
              between the harmonics of the power line frequency.

          24. The method of claim 21 wherein the transmitting of the signal onto the power  
15       line is done in voltage mode.

          25. The method of claim 24 wherein the carrier frequency is about approximately  
              5 kHz.

          26. The method of claim 21 wherein the transmitting of the signal onto the power  
              line is in current mode.

20    27. The method of claim 26 wherein the carrier frequency is about approximately  
              2 KHz.

          28. The method of claim 21 wherein the series of pulses are arranged in packets by  
              a data shifter and packet generator which is clocked by a bit clock driven by a  
              reference at the power line frequency.

25    29. The method of claim 21 wherein the packets are HDLC packets.

- 5 30. The method of claim 29 wherein the packets are coupled to a power line  
frequency tracker which is also coupled to the power line frequency, the power  
line frequency tracker comprising an oscillator constructed and arranged for  
generating an internal reference signal and comprising circuitry for calculating  
the changes in phase between the internal reference signal and the power line  
10 frequency for use as an error signal for driving the voltage controlled oscillator
31. A receiver coupled to a distribution line carrying power at a power line  
frequency and a bandwidth of less than ten Hertz for receiving data therefrom  
as a data signal coded in packets of bytes which are comprised of sequences of  
mark or a space frequency signals to which the receiver is tuned, the receiver  
15 comprising:
  - a power line frequency tracker coupled to receive an input signal  
representative of the power line frequency and generate output frequencies  
representative of the mark and space frequencies to which the receiver is  
tuned;
  - 20 a mixer circuit for mixing the sine and cosine of the pulse and mark  
frequencies generated by the power line frequency tracker and the data  
signal and producing a vector representing the frequency difference  
between the mark frequency and the data signal;
  - a comparison circuit for comparing the vectors and creating a data  
25 stream signal; and

5 a decoder circuit receiving the data stream and producing an output  
representing the data.

32. A method of communication information over a power line transmitting  
power at a power line frequency, the method comprising:

creating a modulated signal representative of the information and having a  
10 carrier frequency which is derived from the power line with carrier frequencies  
between 600 Hz and 10KHz; and  
coupling the modulated signal onto the power line.

33. The method of claim 32 wherein the modulated signal is created using a  
single modulation operation.

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